

07-26-00

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PATENT APPLICATION

IN THE U.S. PATENT AND TRADEMARK OFFICE
 Express Mail Label No.: EL 481 999 926 US
 Attorney Docket No.: OPS Case 498

July 25, 2000

Box Patent Application
 Assistant Commissioner for Patents
 Washington, DC 20231
 Sir:

Transmitted herewith for filing is the patent application of:

Inventor(s) : (1) Yasuhiro MIYAMOTO; (2) Motoharu
 AKIYAMA and (3) Seiji OKAMURA
 For : GREASE COMPOSITION FOR BEARINGS OF
 INFORMATION DEVICES

Enclosed are:

- ☒ Specification
☒ Declaration or Oath
☐ Drawing Sheets ☐ Formal
☐ Informal
☒ Preliminary Amendment Cancelling Claims
☐ Amendment Before First Office Action
☐ Information Disclosure Statement
☐ Statement(s) re small entity (37 CFR 1.9 and 1.27)
☒ Assignment, with Recordation Form Cover Sheet
☒ Acknowledgment Postal Card
☒ Priority is claimed under 35 USC 119 based on Japan
 Application No. 11-359608, filed November 13, 1999.
☒ A certified copy of the priority application is
 enclosed.

The filing fee is calculated as shown below, after entering
 any enclosed Amendment which requests entry before such
 calculation:

For	No. Filed	No. Extra	(X) LG Entity	RATE	() SM Entity	Fee
Basic Fee				\$690.00	\$345.00	\$690.00
Total Claims	(7 - 20 = 0)		x	\$ 18.00	x \$ 9.00	
Indep. Claims	(2 - 3 = 0)		x	\$ 78.00	x \$ 39.00	
<input type="checkbox"/> Multiple Dep. Claim			+	\$260.00	+	\$130.00
* * * TOTAL FILING FEE * * *						\$ 690.00

jc893 U.S. PTO
 07/25/00

JC675 U.S. PTO
 09/625148
 07/25/00

09/625148 07/25/00

PATENT APPLICATION

"Express Mail" Mailing Label No.: EL 481 999 926 US
Date of Mailing: July 25, 2000
Applicant(s): Yasuhiro MIYAMOTO, et al.
Title: GREASE COMPOSITION FOR BEARINGS OF INFORMATION DEVICES

Serial No.: Unknown
Filed: Unknown
Atty Docket No.: OPS Case 498

Assistant Commissioner for Patents
Washington DC 20231



EXPRESS MAILING CERTIFICATE

Sir:

I hereby certify that the attached paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Washington DC 20231.

FLYNN, THIEL, BOUTELL & TANIS, P.C.

By: Amy S. Cunningham

Date: July 25, 2000

Document(s) attached: Patent Application Transmittal dated July 25, 2000 including enclosures listed thereon

Telephone: (616) 381-1156
191.9912

PATENT APPLICATION

Express Mail Label No.: EL 481 999 926 US

IN THE U.S. PATENT AND TRADEMARK OFFICE

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Applicant(s) : Yasuhiro MIYAMOTO, et al.

For : GREASE COMPOSITION FOR BEARINGS OF
INFORMATION DEVICES

Atty. Docket No.: OPS Case 498

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Washington, DC 20231

PRELIMINARY AMENDMENT CANCELLING CLAIMS

Sir:

Prior to calculation of the filing fee in the above-identified application, kindly enter the following:

IN THE CLAIMS

Claim 2, line 1; replace "(1) above" with ---Claim 1---.

Claim 4, line 1; replace "any one of (1) to (3)"
with ---Claim 1---.
line 2; delete "above".

Claim 5, line 1; replace "any one of (1) to (4)"
with ---Claim 1---.
line 2; delete "above".

Claim 6, line 1; replace "any one of (1) to (5)"
with ---Claim 1---.
line 2; delete "above".


Claim 7, line 1; replace "any one of (1) to (6)"
with ---Claim 1---.

line 2; delete "above".

REMARKS

This amendment cancels claim(s) to reduce the filing fee.
Please enter this amendment before calculating the filing fee.

Respectfully submitted,


Terryence F. Chapman

TFC/ad

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	Brian R. Tumm	Reg. No. 36 328

Encl: None

111.9803

003220315960

TITLE OF THE INVENTION

GREASE COMPOSITION FOR BEARINGS OF INFORMATION
DEVICES

BACKGROUND OF THE INVENTION

Field of The Invention

This invention relates to a grease composition, which is adapted for use in bearings of spindle motors ordinarily employed in peripheral information devices such as HDD (hard disk drive) and FDD (floppy disk drive) memories, CDD (compact disk drive), MOD (magneto-optical disk drive) and the like of computer systems, and VTR (video tape recorder).

Description of The Prior Art

In general, performances required for a bearing grease composition, which is employed in peripheral information devices such as HDD (hard disk drive) and FDD (floppy disk drive) memories, CDD (compact disk drive), MOD (magneto-optical disk drive) and the like of computer systems, and VTR (video tape recorder), include a reduced degree of grease dusting or scattering, a small torque, an excellent acoustic property, a long life, and the like.

Especially, with these information devices usually employed in a clean environment, it has been often experienced that a gaseous oil or fine particles of a grease scattered from the inside of a bearing at the time of rotations often cause the surfaces of a disk or the like to

be contaminated, resulting in malfunction of the device. Thus, it has been accepted as the most important how to suppress the amount of the scattered oil or grease. Extensive studies have been made on this area.

In recent years, attention has been paid, as a very important problem to solve, to a phenomenon called fretting. More particularly, when ball bearings particularly used in information devices undergo vibrations at a low frequency of about 5 to 10 Hz caused during the course of carrying out and in of information devices or at the time of carrying such devices, race faces in contact with balls inside a bearing suffer damages and are degraded.

When fretting takes place, the acoustic characteristics of the ball bearing not only are worsened, but also adversely influence the performance of the information device.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a grease composition for bearings of information devices, which ensures not only a high performance and a long life while suppressing an amount of an oil or grease scattered from the bearing, but also such an effect of not causing the fretting phenomenon.

It is another object of the invention to provide a grease composition for bearings of rolling of information devices which can satisfy properties required for the grease composition used in peripheral information devices such as HDD (hard disk drive) and

FDD (floppy disk drive) memories, CDD (compact disk drive), MOD (magneto-optical disk drive) and the like of computer systems, and VTR (video tape recorder), i.e. a reduced degree of dusting or scattering, a small torque, an excellent acoustic property and a long life during the course of high revolutions, and also can suppress the fretting phenomenon from occurring.

It will be noted that the term "bearing of an information device" is intended to mean a bearing of a spindle motor, which is used in the peripheral information devices such as HDD (hard disk drive) and FDD (floppy disk drive) memories, CDD (compact disk drive), MOD (magneto-optical disk drive) and the like of computer systems, and VTR (video tape recorder).

The above objects can be achieved, according to the invention, by a grease composition, which comprises:

a carbonate compound of the following general formula (i) serving as a base oil

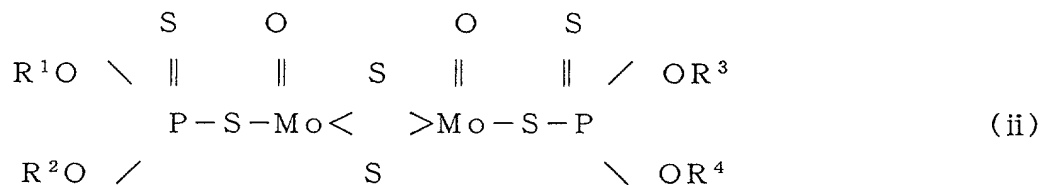


wherein R and R' may be the same or different and independently represent a branched alkyl group having from 13 to 15 carbon atoms;

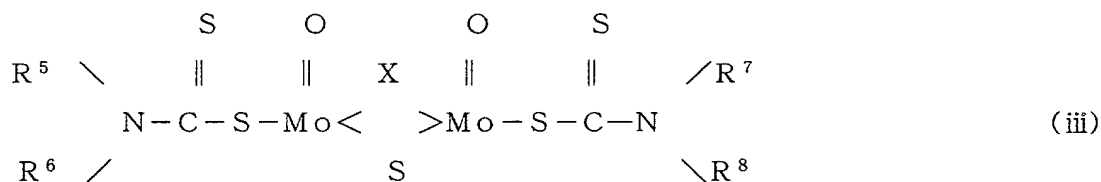
a lithium soap serving as a thickener; and

at least one organomolybdenum compound selected from the group consisting of a molybdenum dithiophosphate of the general

formula (ii)



wherein R¹, R², R³ and R⁴ independently represent an alkyl group having from 1 to 24 carbon atoms or an aryl group having from 6 to 30 carbon atoms, and a molybdenum dithiocarbamate of the general formula (iii)



wherein R⁵, R⁶, R⁷ and R⁸ independently represent an alkyl group having from 1 to 24 carbon atoms, and X represents O or S. This grease composition is excellent in characteristics for use in a bearing of information devices and does not cause any fretting phenomenon to occur.

EMBODIMENTS OF THE INVENTION

When a carbonate compound of the following general formula (i) is used as a base oil,



wherein R and R' may be the same or different and independently represent a branched alkyl group having from 13 to 15 carbon atoms, the resultant grease composition exhibits excellent characteristics such that while characteristic properties required for information devices, e.g. a reduced degree of dusting (scattering) of the grease, a small torque, an excellent acoustic characteristic, a long life, and the like, can be imparted to the device, fretting is not caused to occur.

The carbonate used in the present invention is represented by the formula (I) in which R and R' may independently be a branched alkyl group having from 13 to 15 carbon atoms and may be the same or different. Specific examples include those carbonates of the following general formulas (v), (vi) and (vii)



In the practice of the invention, an alkyl diphenyl ether or a polyol ester may be used in combination as base oil component.

The grease composition of the invention should preferably comprise 70 to 95 parts by weight of the carbonate and 5 to 30 parts by weight of a lithium metal salt.

If the lithium metal salt is less than 5 parts by weight, a mixing consistency becomes so low that the resultant mixture is unfavorably apt to escape or scatter when a bearing filled therewith is rotated, with the possibility that HDD, FDD and the like are contaminated therewith.

On the other hand, when the content exceeds 30 parts by weight, the resultant mixture becomes so hard that the fluidity of the resulting grease composition inside a bearing becomes poor. This may unfavorably lead to a failure in lubrication.

Further, the grease composition for a bearing of information devices according to the invention may further comprise, as a fourth component, additives ordinarily employed in the grease composition, such as antioxidants, rust inhibitors and the like.

The at least one organomolybdenum compound selected from the molybdenum dithiophosphate and the molybdenum dithiocarbamate should preferably be present in an amount of 0.5 to 5 wt%, more preferably from 1 to 3 wt%, based on 100 parts by weight of the total of the base oil and the thickening agent.

Preferred embodiments of the invention are summarized below.

(1) A grease composition for a bearing of information devices

comprising:

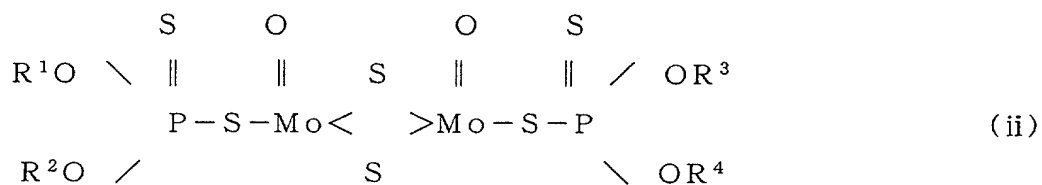
a carbonate compound of the following general formula (i) serving as a base oil



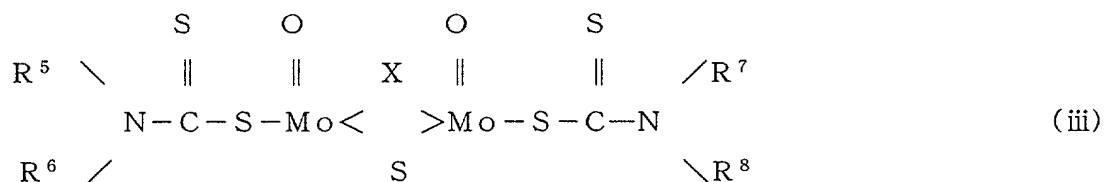
wherein R and R' may be the same or different and independently represent a branched alkyl group having from 13 to 15 carbon atoms;

a lithium soap serving as a thickener; and

at least one organomolybdenum compound selected from the group consisting of a molybdenum dithiophosphate of the general formula (ii)



wherein R¹, R², R³ and R⁴ independently represent an alkyl group having from 1 to 24 carbon atoms or an aryl group having from 6 to 30 carbon atoms, and a molybdenum dithiocarbamate of the general formula (iii)

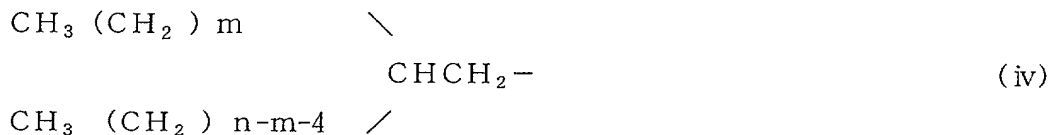


wherein R⁵, R⁶, R⁷ and R⁸ independently represent an alkyl group having from 1 to 24 carbon atoms, and X represents O or S.

(2) The grease composition as recited in (1) above, wherein the base oil is made of a carbonate compound of the following general formula (i)



wherein R and R' may be the same or different and independently represent a branched alkyl group of the following general formula (iv)

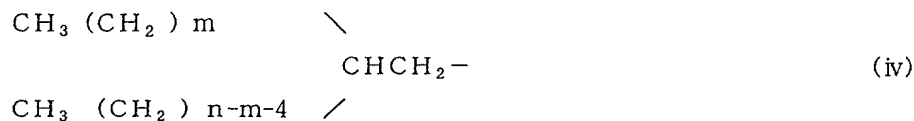


wherein n = 13 to 15 and m = 0 to 6.

(3) A grease composition for a bearing of information devices which comprises 70 to 95 parts by weight of a carbonate compound of the general formula (i)



wherein R and R' may be the same or different and independently represent a branched alkyl group of the following general formula (iv)



wherein n = 13 to 15 and m = 0 to 6, and 5 to 30 parts by weight of a lithium soap.

(4) The grease composition as recited in any one of (1) to (3) above, wherein the lithium soap is made of a lithium metal salt prepared from lithium hydroxide and a higher fatty acid having 10 or more carbon atoms or a higher hydroxy fatty acid having 10 or more carbon atoms.

(5) The grease composition as recited in any one of (1) to (4) above, wherein the thickener consists of a plurality of thickeners.

(6) The grease composition as recited in any one of (1) to (5) above, wherein at least one organomolybdenum compound selected from the molybdenum dithiophosphate and molybdenum dithiocarbamate is present in an amount of 0.5 wt% to 5 wt%, preferably from 1 wt% to 3 wt%, based on 100 parts by weight of the total of the base oil and the thickener.

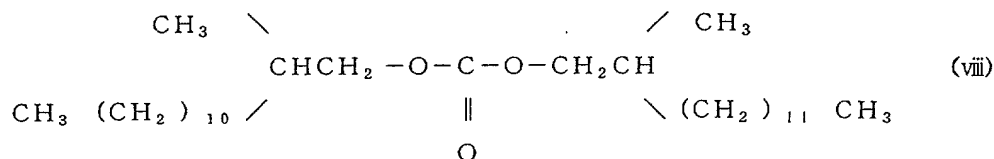
(7) The grease composition as recited in any one of (1) to (6) above, further comprising a fourth component.

The invention is described in more detail by way of examples.

Examples 1 to 8

These examples illustrate grease compositions for bearings of information devices.

A carbonate (hereinafter referred to as carbonate oil A) of the chemical formula (viii), which has a branched alkyl group and corresponds to a compound of the afore-indicated formula (i) in which R is the group of the formula (vi) and R' is the group of the formula (vii),



and lithium stearate and/or lithium 12-hydroxystearate were mixed at ratios indicated in Table 1 so that the total amount was at 100 wt%. While agitating the mixture until the mixture was entirely turned into a fluid, it was heated to 220°C to 230°C. The fluid was poured into a stainless steel container in a thickness of 3 to 5 mm and cooled down to 80°C or below, after which a molybdenum dithiophosphate and/or molybdenum dithiocarbamate was added to as an organomolybdenum compound. Subsequently, the mixture was homogenized by means of a three-roll mill to obtain a grease composition.

Likewise, aside from the carbonate, lithium soap component and organomolybdenum compound, an alkyl diphenyl ether or a

polyol ester was used and formulated at a ratio indicated in Table 1 to obtain grease compositions of Examples 7 and 8.

Comparative Examples 1 to 4

For comparison, two types of commercially available greases whose base oils and thickeners were, respectively, known were provided as Comparative Examples 1 and 2. In Table 2, the symbol "+" indicates formulated components.

Moreover, the base oil and lithium soap were formulated at different ratios indicated in Table 2, and treated in the same manner as in the examples, thereby obtaining grease compositions of Comparative Examples 3, 4, respectively.

The grease compositions of the examples and comparative examples were subjected to measurement of a mixing consistency and a dropping point and also to a motor characteristic test under the same conditions. These results are shown in Tables 1 and 2, respectively.

The mixing consistency was determined according to the method described in JIS K2220 5.3 and the dropping point was determined according to the method described in JIS K2 220 5.4.

The motor characteristic test was performed such that a bearing, in which grease composition to be tested was sealed, was assembled in a spindle motor, and the motor was rotated at normal temperatures at 5,400 r.p.m, to measure noises, an amount of a grease evaporated (scattered), and a torque of rotations.

The noises were measured by use of a microphone located at a

distance of 1 m from the end face of a hub of the motor at the time of the rotations of the motor.

The amount of an evaporated (scattered) grease was determined by measuring the weights of the motor prior to and after the rotations and calculating the difference in the weight. The torque was determined by measuring a current value at the time of the rotations of the motor by means of an ammeter, and the torque stability was calculated from the difference between the maximum current value and the minimum current value.

The results of judgment on the respective evaluation items, which were accorded to the performances required for a bearing grease composition for information devices, are shown in Tables 1 (examples) and 2 (comparative examples).

Smaller noises, a more reduced amount of evaporation (scattering), a lower torque, and a smaller variation of the torque stability are, respectively, better.

The respective performances were evaluated by the four ranks of A = excellent, B = good, C = moderate and D = poor.

Further, with regard to a fretting resistance characteristic, ball bearings, which were, respectively, filled with the grease compositions to a bearing space capacity of 10 to 15 vol%, were vibrated at 9 Hz and applied with an angular acceleration of 29.3 radians/second², under which a generated sound was measured over 60 minutes. This characteristic was evaluated by the four ranks of A = excellent, B = good, C = moderate and D = poor.

Table 1

Example	1	2	3	4	5	6	7	8
Thickener StLi	25		25	25	25	15	20	20
12OH StLi		10				5		
Base carbonate A	75	90	75	75	75	80	70	70
Oil ADE							10	
POE								10
Organomoly- MoDTP bdenum MoDTC	1	1		0.5	1.5 1.5	2	1	1
Viscosity of Base Oil (40°C)	18	18	18	18	18	18	25	21
Mixing consistency (25°C)	199	250	200	210	207	185	212	209
Dropping Point (°C)	198	195	201	197	195	195	196	195
Characteristic Test:								
noises	A	A	A	A	A	A	B	B
degree of scattering	A	B	A	A	A	B	A	A
torque	A	A	A	A	A	A	B	B
torque stability	A	A	A	A	A	A	A	A
fretting resistance	A	A	A	A	A	A	A	A
Overall Evaluation	A	A	A	A	A	A	B	B

Note:

StLi: lithium stearate

12OH StLi: lithium 12-hydroxystearate

ADE: alkyl diphenyl ether

POE: polyol ester oil

Table 2

Comparative Examples	1	2	3	4
Thickener StLi	+		25	25
12OH StLi	+			
Na-complex		+		
Base Oil Carbonate A			75	
Diester	+			38
POE	+			37
Mineral oil		+		
Organomolybdenum MoDTP				1
MoDTC				
Viscosity of Base Oil (40°C)	26	145	18	18
Mixing consistency (25°C)	250	205	202	210
Dropping point (°C)	194	>260	199	196
Characteristic Test:				
noises	C	D	A	A
degree of scattering	B	A	A	C
torque	C	B	A	B
torque stability	D	C	A	A
fretting resistance	D	D	C	B
Overall Evaluation	D	D	B	C

Note:

Na-Complex: sodium complex soap

12OH St-Li: lithium 12-hydroxystearate

POE: polyol ester oil.

It should be noted that in Tables 1, 2, the unit of the viscosity of the base oil is expressed by mm²/s.

As will be apparent from Tables 1 and 2, the grease composition for bearings of information devices according to the invention are reduced in the degree of evaporation or scattering, are low in noises and torque, and have good torque stability. In addition, the composition does not undergo any fretting phenomenon.

WHAT IS CLAIMED IS:

1. A grease composition for a bearing of information devices comprising:

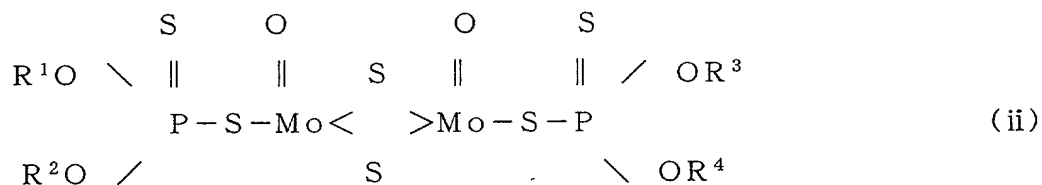
a carbonate compound of the following general formula (i) serving as a base oil



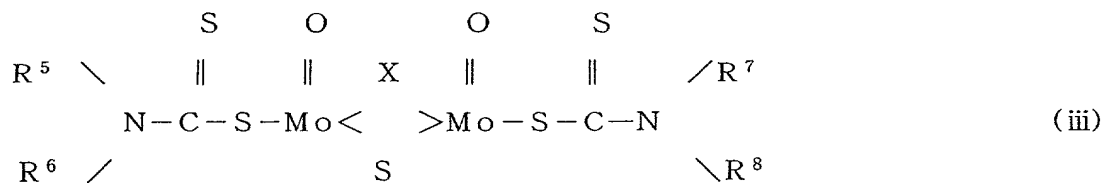
wherein R and R' may be the same or different and independently represent a branched alkyl group having from 13 to 15 carbon atoms;

a lithium soap serving as a thickener; and

at least one organomolybdenum compound selected from the group consisting of a molybdenum dithiophosphate of the general formula (ii)

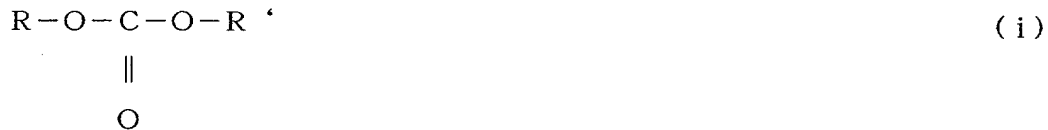


wherein R¹, R², R³ and R⁴ independently represent an alkyl group having from 1 to 24 carbon atoms or an aryl group having from 6 to 30 carbon atoms, and a molybdenum dithiocarbamate of the general formula (iii)

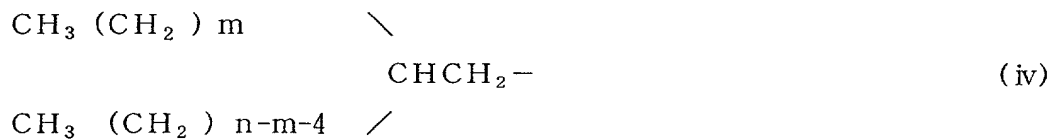


wherein R⁵, R⁶, R⁷ and R⁸ independently represent an alkyl group having from 1 to 24 carbon atoms, and X represents O or S.

2. The grease composition as recited in (1) above, wherein the base oil is made of a carbonate compound of the following general formula (i)



wherein R and R' may be the same or different and independently represent a branched alkyl group of the following general formula (iv)

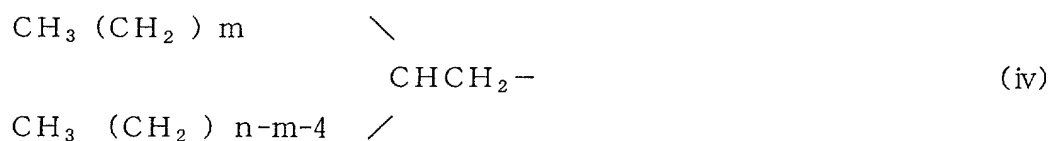


wherein n = 13 to 15 and m = 0 to 6.

3. A grease composition for a bearing of information devices which comprises 70 to 95 parts by weight of a carbonate compound of the general formula (i)



wherein R and R' may be the same or different and independently represent a branched alkyl group of the following general formula (iv)



wherein n = 13 to 15 and m = 0 to 6, and 5 to 30 parts by weight of a lithium soap.

4. The grease composition as recited in any one of (1) to (3) above, wherein the lithium soap is made of a lithium metal salt prepared from lithium hydroxide and a higher fatty acid having 10 or more carbon atoms or a higher hydroxy fatty acid having 10 or more carbon atoms.

5. The grease composition as recited in any one of (1) to (4) above, wherein the thickener consists of a plurality of thickeners.

6. The grease composition as recited in any one of (1) to (5) above, wherein at least one organomolybdenum compound selected from the molybdenum dithiophosphate and molybdenum dithiocarbamate is present in an amount of 0.5 wt% to 5 wt%, preferably from 1 wt% to 3 wt%, based on 100 parts by weight of the total of the base oil and the thickener.

7. The grease composition as recited in any one of (1) to (6) above, further comprising a fourth component.

ABSTRACT OF THE DISCLOSURE

A grease composition for bearings of information devices comprising a carbonate base oil, a lithium soap, and at least one organomolybdenum compound selected from molybdenum dithiophosphates and molybdenum dithiocarbanates.

Declaration and Power of Attorney For Patent Application

As a below named inventor, we hereby declare that:

Our residence, post office address and citizenship are as stated next to our name.

We believe we are the original, first and joint inventors of the subject matter which is claimed and for which a patent is sought on the invention entitled.

GREASE COMPOSITION FOR BEARINGS OF

INFORMATION DEVICES

the specification of which is attached hereto unless the following box is checked:

☐ was filed on _____ as United States
Application Number _____ or PCT International Application
Number _____ and was amended on _____ (if
applicable).

We hereby state that we have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

We acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

We here by claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)

Priority Not Claimed

11-359608

Japan

13 November 1999

(Number)

(Country)

(Day/Month/Year Filed)

☐

(Number)

(Country)

(Day/Month/Year Filed)

☐

We hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.)

Filing Date

We hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, we acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of application.

(Status: Patented, Pending, Abandoned)

We hereby declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, we hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (*list name and registration number*)

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David G. Boutell, Reg. No. 25 072	Sindy B. Williams, Jr., Reg. No. 24 949
Ronald J. Tanis, Reg. No. 22 724	Timothy B. Clise, Reg. No. 40 957
Terryence F. Chapman, Reg. No. 32 549.	Liane L. Churney, Reg. No. 40 694
Mark L. Maki, Reg. No. 36 589	Brian R. Tumm, Reg. No. 36 328

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Direct Telephone Calls to: (*name and telephone number*)

Full name of first inventor
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Inventor's signature

Yasuhiro Miyamoto

Date

7/JUL/2000

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Citizenship

Japanese

Post Office Address

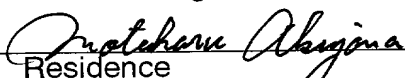
c/o Nippon Grease Co., Ltd. Technical Research Laboratory
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[X] Additional inventors are being named on the one supplemental additional inventor(s) sheet.

Full name of second joint inventor
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Inventor's signature

Date



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